

Evolution of the Space Station Robotic Manipulator

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The Space Station Remote Manipulator System (SSRMS), Canadarm2, was launched in 2001 and deployed on the International Space Station (ISS). The Canadarm2 has been instrumental in ISS assembly and maintenance. Canadarm2 shares its heritage with the Space Shuttle Arm (Canadarm).

This article explores the evolution from the Shuttle Canadarm to the Space Station Canadarm2 design, which incorporates a 7 degree of freedom design, larger joints, and changeable operating base. This article also addresses phased design, redundancy, life and maintainability requirements.

The design of Canadarm2 meets unique ISS requirements, including expanded handling capability and the ability to be maintained on orbit. The size of ISS necessitated a mobile manipulator, resulting in the unique capability of Canadarm2 to relocate by performing a walk off to base points located along the Station, and interchanging the tip and base of the manipulator. This provides the manipulator with reach and access to a large part of the Station, enabling on-orbit assembly of the Station and providing support to Extra-Vehicular Activity (EVA).

Canadarm2 is evolving based on on-orbit operational experience and new functionality requirements. SSRMS functionality is being developed in phases to support evolving ISS assembly and operation as modules are added and the Station becomes more complex. Changes to sustaining software, hardware architecture, and operations have significantly enhanced SSRMS capability to support ISS mission requirements. As a result of operational experience, SSRMS changes have been implemented for Degraded Joint Operations, Force Moment Sensor Thermal Protection, Enabling Ground Controlled Operations, and Software Commutation. Planned Canadarm2 design modifications include: Force Moment Accommodation, Smart Safing, Separate Safing, and Hot Backup.

In summary, Canadarm2 continues to evolve in support of new ISS requirements and improved operations. It is a tribute to the design that this evolution can be accomplished while conducting critical on-orbit operations with minimal hardware changes.